Geophysical Research Abstracts
Vol. 19, EGU2017-19245-1, 2017
EGU General Assembly 2017

Lithosphere destabilization by melt percolation during pre-oceanic rifting: Evidence from Alpine-Apennine ophiolitic peridotites

Giovanni Piccardo (1) and Giorgio Ranalli (2)

(1) University of Genova, Genova 16132, Italy (giovanni.b.piccardo@gmail.com), (2) Department of Earth Sciences, Carleton University, Ottawa K1S 5B6, Canada(giorgioranalli@cunet.carleton.ca)

Orogenic peridotites from Alpine-Apennine ophiolite Massifs (Lanzo, Voltri, External and Internal Ligurides, -NW Italy, and Mt. Maggiore – Corsica) derive from the mantle lithosphere of the Ligurian Tethys. Field/structural and petrologic/geochemical studies provide constraints on the evolution of the lithospheric mantle during pre-oceanic passive rifting of the late Jurassic Ligurian Tethys ocean.
Continental rifting by far-field tectonic forces induced extension of the lithosphere by means of km-scale extensional shear zones that developed before infiltration of melts from the asthenosphere (Piccardo and Vissers, 2007). After significant thinning of the lithosphere, the passively upwelling asthenosphere underwent spinel-facies decompression melting along the axial zone of the extensional system.
Silica-undersaturated melt fractions percolated through the lithospheric mantle via diffuse/focused porous flow and interacted with the host peridotite through pyroxenes-dissolving/olivine-precipitating melt/rock reactions. Pyroxene dissolution and olivine precipitation modified the composition of the primary silica-undersaturated melts into derivative silica-saturated melts, while the host lithospheric spinel lherzolites were transformed into pyroxene-depleted/olivine-enriched reactive spinel harzburgites and dunites.
The derivative liquids interacted through olivine-dissolving/orthopyroxene+plagioclase-crystallizing reactions with the host peridotites that were impregnated and refertilized (Piccardo et al., 2015). The saturated melts stagnated and crystallized in the shallow mantle lithosphere (as testified by diffuse interstitial crystallization of euhedral orthopyroxene and anhedral plagioclase) and locally ponded, forming orthopyroxene-rich/olivine-free gabbro-norite pods (Piccardo and Guarnieri, 2011).
Reactive and impregnated peridotites are characterized by high equilibration temperatures (up to 1250 °C) even at low pressure, plagioclase-peridotite facies conditions. This indicates that thermal advection by percolation of hot asthenospheric melts significantly heated the lithospheric mantle column above the melting asthenosphere.
Numerical and analogue models show that infiltration of melts results in considerable softening of mantle rocks. Total ithospheric strength can be decreased from 10 to 1 TN m-1 as orders of magnitude and the sin-rift thermo-mechanical erosion of the lithospheric mantle induces significant rheological softening along the axial zone of extension (Corti et al., 2007; Ranalli et al., 2007).
Softening of the lithospheric mantle may lead to whole lithospheric failure and consequently to transition from continental extension to oceanic spreading.
Therefore, rheological softening caused destabilization of the lithospheric mantle between the future continental margins (Piccardo et al., 2014; Piccardo, 2016) of the Ligurian Tethys. The wedge of destabilized lithosphere favored faster divergence of the continental blocks and enhanced doming and thermal buoyancy of deeper/hotter asthenosphere that rose between the future continental margins and originated aggregated MORB melts (i.e. the oceanic magmatism that formed olivine-gabbro intrusions and pillowed basalt extrusions).
Lithosphere destabilization by melt percolation can play a fundamental role in the geodynamic evolution of lithosphere extension causing transition from continental extension to continental break-up to oceanic spreading.

Corti, G., Bonini, M., Innocenti, F., Manetti, P., Piccardo, G.B., Ranalli, G., 2007. Journal of Geodynamics, 43, 465-483.
Piccardo, G.B., Padovano, M., Guarnieri, L. 2014. Earth-Science Reviews, 138, 409–434.
Piccardo, G.B., 2016. Gondwana Research, 39, 230-249.
Piccardo, G.B., Vissers, R.L.M., 2007. Journal of Geodynamics, 43, 417-449.
Piccardo, G.B., Guarnieri, L., 2011. Lithos, 124, 210-214.
Ranalli, G., Piccardo, G.B., Corona-Chavez, P., 2007. Journal of Geodynamics, 43, 450-464.